

- 58 -

## CLAIMS

We claim:

1. A method comprising:  
processing run level information in a multi-layer representation for a sequence  
5 of values; and  
outputting a result.
  
2. A computer-readable medium storing computer-executable instructions for  
causing a video encoder programmed thereby to perform the method of claim 1.  
10
  
3. A computer-readable medium storing computer-executable instructions for  
causing a video decoder programmed thereby to perform the method of claim 1.
  
4. The method of claim 1 wherein the values are frequency transform  
15 coefficients.
  
5. The method of claim 4 wherein the sequence is zigzag scanned using a scan  
pattern selected from among plural available scan patterns for variable-size blocks.
  
- 20 6. The method of claim 1 wherein the processing includes processing plural  
first-layer runs as one or more second-layer runs and one or more second-layer levels.
  
7. The method of claim 6 wherein each of the plural first-layer runs represents a  
run of zero or more zero values in the sequence.  
25
  
8. The method of claim 6 wherein each of the one or more second-layer runs  
represents a run of zero or more insignificant-value first-layer runs.
  
9. The method of claim 6 wherein each of the one or more second-layer levels  
30 represents a single significant-value first-layer run.

- 59 -

10. The method of claim 6 further including processing at least some of the one or more second-layer runs using a separate Huffman code per second-layer run.

11. The method of claim 6 further including processing at least some of the one 5 or more second-layer levels using a separate Huffman code per second-layer level.

12. The method of claim 6 further including processing a count of significant second-layer runs, wherein the count at least in part enables reduction in code table size and/or early termination of decoding.

10

13. The method of claim 1 wherein the processing includes processing plural first-layer levels as one or more second-layer runs and one or more second-layer levels.

15

14. The method of claim 13 wherein each of the plural first-layer levels represents a non-zero value in the sequence.

15. The method of claim 13 wherein each of the one or more second-layer runs represents a run of zero or more insignificant-value first-layer levels.

20

16. The method of claim 13 wherein each of the one or more second-layer levels represents a single significant-value first-layer level.

17. The method of claim 13 further including processing at least some of the one or more second-layer runs using a separate Huffman code per second-layer run.

25

18. The method of claim 13 further including processing at least some of the one or more second-layer levels using a separate Huffman code per second-layer level.

30

19. The method of claim 13 further including processing a count of significant second-layer levels, wherein the count at least in part enables reduction in code table size and/or early termination of decoding.

- 60 -

20. The method of claim 1 wherein the processing includes using embedded Huffman code tables for the information in the multi-level representation, and wherein the embedded Huffman code tables are shared for plural different variable-size blocks.

5 21. The method of claim 1 wherein the processing includes using zoned Huffman code tables for the information in the multi-level representation.

22. In a video processing tool, a method comprising:  
for each of plural sequences of frequency transform coefficients,  
10 processing run level information for the sequence in a two-layer representation, including processing one or more first-layer runs as one or more second-layer runs and one or more second-layer levels; and  
outputting a result.

15 23. A computer-readable medium storing computer-executable instructions for causing a video encoder programmed thereby to perform the method of claim 22.

24. A computer-readable medium storing computer-executable instructions for causing a video decoder programmed thereby to perform the method of claim 22.

20 25. The method of claim 22 wherein each of the one or more first-layer runs represents a run of zero or more zero values in the sequence.

25 26. The method of claim 22 wherein each of the one or more second-layer runs represents a run of zero or more zero-value first-layer runs.

27. The method of claim 22 wherein each of the one or more second-layer levels represents a single non-zero value first-layer run.

30 28. In a video processing tool, a method comprising:  
for each of plural sequences of frequency transform coefficients,

- 61 -

processing run level information for the sequence in a two-layer representation, including processing one or more first-layer levels as one or more second-layer runs and one or more second-layer levels; and  
outputting a result.

5

29. A computer-readable medium storing computer-executable instructions for causing a video encoder programmed thereby to perform the method of claim 28.

10 30. A computer-readable medium storing computer-executable instructions for causing a video decoder programmed thereby to perform the method of claim 28.

31. The method of claim 28 wherein each of the one or more first-layer levels represents a non-zero value in the sequence.

15 32. The method of claim 28 wherein each of the one or more second-layer runs represents a run of zero or more first-layer levels having an absolute value of one.

33. The method of claim 28 wherein each of the one or more second-layer levels represents a single first-layer level having an absolute value of two or more.

20

34. In a video processing tool, a method comprising:  
processing an entropy code that jointly represents a number of non-zero levels in a sequence and whether the non-zero levels all have insignificant values; and  
outputting a result.

25

35. A computer-readable medium storing computer-executable instructions for causing an encoder programmed thereby to perform the method of claim 34.

30 36. A computer-readable medium storing computer-executable instructions for causing a decoder programmed thereby to perform the method of claim 34.

- 62 -

37. The method of claim 34 wherein each of the insignificant values has an absolute value of one.

38. In a video processing tool, a method comprising:  
5       processing an entropy code that jointly represents a number of significant levels for a sequence and a particular single significant level absolute value; and  
          outputting a result.

39. A computer-readable medium storing computer-executable instructions for  
10      causing an encoder programmed thereby to perform the method of claim 38.

40. A computer-readable medium storing computer-executable instructions for causing a decoder programmed thereby to perform the method of claim 38.

15       41. The method of claim 38 wherein the number of significant levels is one, and wherein the particular single significant level absolute value is 2.

20       42. In a video processing tool, a method comprising:  
          processing run length or run level information for a sequence, including  
          processing a count of significant values in the sequence, wherein the count at least in part enables reduction in code table size and/or creates opportunities for early termination of decoding; and  
          outputting a result.

25       43. A computer-readable medium storing computer-executable instructions for causing an encoder programmed thereby to perform the method of claim 42.

44. A computer-readable medium storing computer-executable instructions for causing a decoder programmed thereby to perform the method of claim 42

30

45. The method of claim 42 wherein the sequence is a sequence of frequency transform coefficients.

- 63 -

46. The method of claim 42 wherein the count is a number of significant runs.

47. The method of claim 42 wherein the count is a number of significant levels.

5           48. The method of claim 42 wherein information is multi-layer run level information.

10          49. The method of claim 42 wherein the processing further includes processing a count of non-zero values in the sequence.

              50. The method of claim 42 wherein the processing proceeds in a back-to-front manner to improve the reduction in code table size and/or the early termination.

15          51. In a video processing tool, a method comprising:  
                 processing run length or run level information, including processing a Huffman code in a zone of a zoned Huffman code table; and  
                 outputting a result.

20          52. The method of claim 51 wherein the Huffman code is for a number of zeros up to a last non-zero coefficient in a sequence, and wherein the zone is selected based at least in part upon a number of non-zero coefficients in the sequence.

              53. The method of claim 51 wherein the Huffman code is for a run of insignificant levels in a sequence, and wherein the zone is selected based at least in part upon a number of non-zero coefficients in the sequence or a number of insignificant levels left in the sequence.

25          54. The method of claim 51 wherein the Huffman code is for a number of significant levels in a sequence, and wherein the zone is selected based at least in part upon a number of non-zero coefficients in the sequence.

- 64 -

55. The method of claim 51 wherein the Huffman code is for a number of significant runs in a sequence, and wherein the zone is selected based at least in part upon a maximum possible number of significant runs in the sequence.

5 56. The method of claim 51 wherein the Huffman code is for a value of a significant run in a sequence, and wherein the zone is selected based at least in part upon a maximum possible value for the significant run.

10 57. The method of claim 51 wherein the Huffman code is for a run of insignificant runs in a sequence, and wherein the zone is selected based at least in part upon a number of insignificant runs left in the sequence.

15 58. A computer-readable medium storing computer-executable instructions for causing a decoder programmed thereby to perform the method of claim 51, wherein the information is for a sequence of frequency transform coefficients.

59. A computer-readable medium storing computer-executable instructions for causing an encoder programmed thereby to perform the method of claim 51, wherein the information is for a sequence of frequency transform coefficients.

20 60. The method of claim 51 wherein the information is multi-layer run level information.

25 61. In a video processing tool, a method comprising:  
processing Huffman codes for run length or run level information using embedded Huffman code tables, wherein the embedded Huffman code tables include a first table for a first block size that embeds a second table for a second block size smaller than the first block size; and  
outputting a result.

30 62. A computer-readable medium storing computer-executable instructions for causing a decoder programmed thereby to perform the method of claim 61.

- 65 -

63. A computer-readable medium storing computer-executable instructions for causing an encoder programmed thereby to perform the method of claim 61.

5 64. The method of claim 61 wherein the information is multi-layer run level information.

65. The method of claim 61 wherein the first block size is 64 values for an 8x8 block, and wherein the second block size is 32 values for an 8x4 and/or 4x8 block.

10

66. The method of claim 61 wherein the second table embeds a third table for a third block size smaller than the second block size.

15 67. The method of claim 66 wherein the first block size is 64 values for an 8x8 block, wherein the second block size is 32 values for an 8x4 and/or 4x8 block, and wherein the third block size is 16 values for a 4x4 block